**3.4 The Genetic code and Protein Synthesis question pack 2016**

**Q1.**          **Figure 1** shows a short section of a DNA molecule.

**Figure 1**

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(a)     Name parts **R** and **Q**.

(i)      **R** ....................................................

(ii)     **Q** ....................................................

**(2)**

(b)     Name the bonds that join **A** and **B**.

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**(1)**

(c)     Ribonuclease is an enzyme. It is 127 amino acids long.

          What is the minimum number of DNA bases needed to code for ribonuclease?



**(1)**

(d)     **Figure 2** shows the sequence of DNA bases coding for seven amino acids in the enzyme ribonuclease.

**Figure 2**

**G  T  T  T  A  C  T  A  C  T  C  T  T  C  T  T  C  T  T  T  A**

The number of each type of amino acid coded for by this sequence of DNA bases is shown in the table.

|  |  |
| --- | --- |
| **Amino acid** | **Number present** |
| Arg | 3 |
| Met | 2 |
| Gln | 1 |
| Asn | 1 |

Use the table and **Figure 2** to work out the sequence of amino acids in this part of the enzyme. Write your answer in the boxes below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Gln |   |   |   |   |   |   |

**(1)**

(e)     Explain how a change in a sequence of DNA bases could result in a non-functional enzyme.

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**(3)**

**(Total 8 marks)**

**Q2.**          The table shows the sequence of bases on part of the coding strand of DNA.

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| --- | --- | --- | --- | --- | --- | --- |
| Base sequence on coding strand of DNA | **C** | **G** | **T** | **T** | **A** | **C** |
| Base sequence of mRNA |   |   |   |   |   |   |

(a)     Complete the table to show the base sequence of the mRNA transcribed from this DNA strand.

**(2)**

(b)     A piece of mRNA is 660 nucleotides long but the DNA coding strand from which it was transcribed is 870 nucleotides long.

(i)      Explain this difference in the number of nucleotides.

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**(1)**

(ii)     What is the maximum number of amino acids in the protein translated from this piece of mRNA? Explain your answer.

Number of amino acids .......................................................................

Explanation .........................................................................................

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**(2)**

(c)     Complete the table to give **two** differences between the structure of mRNA and the structure of tRNA.

|  |  |
| --- | --- |
| **mRNA** | **tRNA** |
|   |   |
|   |   |

**(2)**

**(Total 7 marks)**

 **Q3.**          (a)     **Table 1** shows some of the events which take place in protein synthesis.

|  |  |  |
| --- | --- | --- |
|   | **A** | tRNA molecules bring specific amino acids to the mRNA molecule |
|   | **B** | mRNA nucleotides join with exposed DNA bases and form a molecule of mRNA |
|   | **C** | The two strands of a DNA molecule separate |
|   | **D** | Peptide bonds form between the amino acids |
|   | **E** | The mRNA molecule leaves the nucleus |
|   | **F** | A ribosome attaches to the mRNA molecule |

**Table 1**

(i)      Write the letters in the correct order to show the sequence of events during protein synthesis, starting with the earliest.

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**(2)**

(ii)     In which part of a cell does **C** take place?

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**(1)**

(iii)     Which of **A - F** are involved in translation?

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**(1)**

(b)     **Table 2** shows some mRNA codons and the amino acids for which they code.

|  |  |  |
| --- | --- | --- |
|   | **mRNA codon** | **Amino acid** |
|   | GUU | Valine |
|   | CUU | Leucine |
|   | GCC | Alanine |
|   | AUU | Isoleucine |
|   | ACC | Threonine |

**Table 2**

(i)      A tRNA molecule has the anticodon UAA.  Which amino acid does the tRNA molecule carry?

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**(1)**

(ii)     Give the DNA base sequence that codes for threonine.

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**(1)**

**(Total 6 marks)**

**Q4.**          (a)     The table shows the mRNA codons for some amino acids.

|  |  |  |
| --- | --- | --- |
|   | **Codon** | **Amino acid** |
|   | CUA | Leucine |
|   | GUC | Valine |
|   | ACG | Threonine |
|   | UGC | Cysteine |
|   | GCU | Alanine |
|   | AGU | Serine |

(i)      Give the DNA sequence coding for cysteine.

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**(1)**

(ii)     Name the amino acid coded by the tRNA anticodon UCA.

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**(1)**

(b)     A particular gene is 562 base-pairs long. However, the resulting mRNA is only 441 nucleotides long. Explain this difference.

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**(1)**

(c)     Tetracycline binds to bacterial ribosomes. This is shown in the diagram.



Protein synthesis in bacteria is similar to that in eukaryotic cells. Explain how tetracycline stops protein synthesis.

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**(2)**

**(Total 5 marks)**

**Q5.**          Read the following passage.

The sequence of bases in a molecule of DNA codes for proteins. Different sequences of bases
code for different proteins. The genetic code, however, is degenerate. Although the base
sequence AGT codes for serine, other sequences may also code for this same amino acid.
There are four base sequences which code for the amino acid glycine. These are CCA, CCC,

5    CCG and CCT. There are also four base sequences coding for the amino acid proline. These

are GGA, GGC, GGG and GGT.

Pieces of DNA which have a sequence where the same base is repeated many times are called
“slippery”. When “slippery” DNA is copied during replication, errors may occur in copying.
Individual bases may be copied more than once. This may give rise to differences in the

10  protein which is produced by the piece of DNA containing the errors.

          Use information in the passage and your own knowledge to answer the following questions.

(a)     Different sequences of bases code for different proteins (lines 1 – 2). Explain how.

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**(2)**

(b)     The base sequence AGT codes for serine (lines 2 – 3). Give the mRNA codon transcribed from this base sequence.

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**(2)**

(c)     Glycine-proline-proline is a series of amino acids found in a particular protein. Give the sequence of DNA bases for these three amino acids which contains the longest “slippery” sequence.

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**(2)**

(d)     (i)      Explain how copying bases more than once may give rise to a difference in the protein (lines 9 – 10).

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**(2)**

(ii)     At what stage in the cell cycle would these errors in copying DNA bases occur?

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**(1)**

(e)     Starting with mRNA in the nucleus of a cell, describe how a molecule of protein is synthesised.

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**(6)**

**(Total 15 marks)**

**Q6.**(a) **Figure 1** shows the exposed bases (anticodons) of two tRNA molecules involved in the synthesis of a protein. **Figure 1**

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Complete the boxes to show the sequence of bases found along the corresponding section of the coding DNA strand.

**(2)**

(b)     Describe the role of tRNA in the process of translation.

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**(3)**

(c)     **Figure 2** shows the sequence of bases in a section of DNA coding for a polypeptide of seven

 amino acids.

**Figure 2**

TACAAGGTCGTCTTTGTCAAG

The polypeptide was hydrolysed. It contained four different amino acids. The number of each type obtained is shown in the table.

|  |  |
| --- | --- |
| **Amino acid** | **Number present** |
| Phe | 2 |
| Met | 1 |
| Lys | 1 |
| Gln | 3 |

Use the base sequence shown in **Figure 2** to work out the order of amino acids in the polypeptide. Write your answer in the table below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  Met |   |   |   |   |   |   |

**(2)**

**(Total 7 marks)**

 **Q7.**The diagram below represents one process that occurs during protein synthesis.

 

(a)     Name the process shown.

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**(1)**

(b)     Identify the molecule labelled **Q**.

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**(1)**

(c)     In the diagram above, the first codon is AUG. Give the base sequence of:

the complementary DNA base sequence .....................................................

the missing anticodon ...................................................................................

The table below shows the base triplets that code for two amino acids.

|  |  |  |
| --- | --- | --- |
|   | **Amino acid** | **Encoding base triplet** |
|   | Aspartic acid | GAC, GAU |
|   | Proline | CCA, CCG, CCC, CCU |

**(2)**

(d)     Aspartic acid and proline are both amino acids. Describe how two amino acids differ from one another. You may use a diagram to help your description.

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**(1)**

(e)     Deletion of the sixth base (G) in the sequence shown in the diagram above would change the nature of the protein produced but substitution of the same base would not. Use the information in the table and your own knowledge to explain why.

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*(Extra space)* ................................................................................................

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**(3)**

**(Total 8 marks)**

**Q8.**          The diagram shows a short sequence of DNA bases.

**T T T G T A T A C T A G T C T A C T T C G T T A A T A**

(a)     (i)      What is the maximum number of amino acids for which this sequence of DNA bases could code?



**(1)**

(ii)The number of amino acids coded for could be fewer than your answer to part (a)(i).

Give **one** reason why.

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**(1)**

(b)Explain how a change in the DNA base sequence for a protein may result in a change in the structure of the protein.

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*(Extra space) .*...............................................................................................

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**(3)**

(c)A piece of DNA consisted of 74 base pairs. The two strands of the DNA, strands **A** and **B**, were analysed to find the **number** of bases of each type that were present. Some of the results are shown in the table.

|  |  |  |
| --- | --- | --- |
|   |   | **Number of bases** |
|   |   | C | G | A | T |
|   | Strand **A** | 26 |   |   |   |
|   | Strand **B** | 19 |   | 9 |   |
|   |  |  |  |  |  |  |

Complete the table by writing in the missing values.

**(2)**

**(Total 7 marks)**

**Q9.**(a)     Messenger RNA (mRNA) is used during translation to form polypeptides.
Describe how mRNA is produced in the nucleus of a cell.

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**(6)**

(b)     Describe the structure of proteins.

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**(5)**

(c)     Describe how proteins are digested in the human gut.

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**(4)**

**(Total 15 marks)**